

BU999175

REMARKS

Claims 2, 3, 6, 9, 10, 13, and 22-30, all the claims pending in the application, stand rejected on prior art grounds. Claims 3, 6, 10, 13, 22, 23, 27, and 28 are amended herein, and claims 1, 4, 5, 7, 8, 11, 12, and 14 have been cancelled without prejudice or disclaimer. Claims 29-31 are added herein. Applicants respectfully traverse these rejections based on the following discussion.

I. The Prior Art Rejections

Claims 2, 3, and 6 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kumar et al. (US Patent No. 5,290,732) in view of Zhao et al. (US Patent No. 5,674,787). Claims 4, 7, 9-11, 13, 14, and 22-28 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kumar et al. in view of Zhao et al. and further in view of Chang et al. (US Patent No. 5,048,744) and Ilavemann (US Patent No. 6,156,651). Applicants respectfully traverse these rejections based on the following discussion.

Regarding claims 2, 3, 6, and 22 the Office Action argues that Kumar discloses a metallurgical structure in an integrated circuit (IC) chip having underlying circuitry/ components within an exterior covering comprising a passivation layer/exterior covering (16b in Fig. 10) a via/hole (cited in Fig. 10) through the passivation layer extending to a metal line (18b in Fig. 10). The Office Action cites 40b in Fig. 10. Also, the Office Action asserts that Kumar discloses a

BU999175

barrier layer lining the via metal layers/plug (in 40b in Fig. 10) in the via above the barrier layer wherein the metal plug, barrier layer and the passivation layer form a planar exterior surface of the metallurgical structure, and (40b in Fig. 10) in the via above the barrier layer comprising copper, and a solder bump/connector (44 in Fig. 10) formed a direct contact with the conductive/metal plug (40b in Fig. 10) and the bump being on the planar exterior surface (Fig. 10, Col. 5, line 23; Col. 6, line 15; Fig. 5-10, Col. 3-12). However, the Office Action admits that Kumar fails to specify the metal plug and the line/pad comprising the same material such as copper. Nonetheless, the Office Action suggests that Zhao teaches using the metal plug (23 in Fig. 6) and the metal line comprises of conventional such as copper (Col. 5, line 22; Col. 7, line 25).

Therefore, according to the Office Action, it would have been obvious to a person of ordinary skill in the art at the time invention was made, to incorporate the metal plug and the metal line comprising copper to achieve and desired electrical resistance and improved electrical performance for the interconnect structure using Zhao's material in Kumar's structure.

Regarding claim 3, the Office Action proposes that Kumar discloses the barrier layer comprising one or more layers of Ti, TiN, Ta and TaN (Col 3, line 30; Col. 4, line 11) to provide the diffusion barrier between the bumps and the metal pad/line.

With respect to the rejections to claims 4 and 7, Applicants hereby cancel claims 4 and 7 without prejudice or disclaimer. Regarding claims 9-11, 13, 14, and 22, the Office Action applies the same rejections for these claims as explained above for claims 6, 2-4, 7, and 6, respectively. Applicants hereby cancel claims 11 and 14 without prejudice or disclaimer.

BU999175

Regarding claims 23-26, the Office Action applies the same rejections for these claims as explained above for claims 6 and 2-4.

Kumar discloses an ionized metal cluster beam deposition of metal bumps on substrates such as multi-chip modules and integrated circuit chips is enhanced. The present invention discloses wet etching techniques for removing unwanted metal deposited on the substrate around bumps, and multiple sources for depositing alloyed (tin-lead) bumps with constant composition.

Zhao discloses a method of utilizing electroless copper deposition to selectively form encapsulated copper plugs to connect conductive regions on a semiconductor. A via opening in an inter-level dielectric (ILD) provides a path for connecting two conductive regions separated by the ILD. Once the underlying metal layer is exposed by the via opening, a SiN or SiON dielectric encapsulation layer is formed along the sidewalls of the via. Then, a contact displacement technique is used to form a thin activation layer of copper on a barrier metal, such as TiN, which is present as a covering layer on the underlying metal layer. After the contact displacement of copper on the barrier layer at the bottom of the via, an electroless copper deposition technique is then used to auto-catalytically deposit copper in the via. The electroless copper deposition continues until the via is almost filled, but leaving sufficient room at the top in order to form an upper encapsulation layer. The SiN or SiON sidewalls, the bottom barrier layer and the cap barrier layer function to fully encapsulate the copper plug in the via. The plug is then annealed.

Chang discloses the fluxless bonding in a reducing atmosphere of integrated circuit contacts containing copper is enhanced using a layer of 200 to 1500 Angstrom thick palladium

BU999175

which inhibits copper oxide formation before fusion and reduces all oxides to promote wetting during fusion.

Havemann discloses a method of forming mechanically robust vias and entrenched conductors on a dielectric layer (which dielectric layer is on an electronic microcircuit substrate which vias and entrenched conductors are electrically connected to a conductive area on the surface of the substrate) and a structure formed thereby. Generally some of the dielectric layers added above the microcircuit comprise a porous dielectric having a desirable low dielectric constant but low mechanical robustness. Special methods are described which generally comprise: forming the dielectric layer over the substrate; forming a nonporous dielectric layer over the substrate; depositing a planarizing stopping material over the top surface of said nonporous dielectric; depositing and patterning photoresist; etching said stopping material and nonporous dielectric layer in a conductor pattern to expose at least a portion of said conductive area on the surface of said substrate; depositing a wall seed depositing conductor metal; and planarizing said structure. Generally the via metal and the conductor metal consist essentially of aluminum, copper or combinations thereof. The conductor metal may be doped with the selectively deposited via metal being doped by dopant diffusion from the conductor metal, thereby avoiding the difficulty of depositing a doped selective metal. Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical effects.

As amended, the claimed invention discloses, "a second barrier layer above said first metal plug; a second metal plug above said second barrier layer, wherein said second metal plug, said first barrier layer, and said second barrier layer form a planar exterior surface of said

BU999175

integrated circuit structure." Moreover, the claimed invention, in claim 13, discloses, "wherein said second metal plug being in direct contact with said solder bump, wherein said first metal plug, said second metal plug, and said metal line comprise a same material, wherein said second metal plug forms sufficient intermetallics with elements diffusing from said solder bump so as to prevent said elements from penetrating through said first barrier layer and said second barrier layer into said metal line."

These unique aspects of the claimed invention achieves a minimum intermetallic formation and maximum protection of the integrated circuit copper wiring from diffusion of elements contained in the solder bump. Contrary to this, nowhere in Kumar, either in the figures or the specification are multiple barrier layers or multiple metal plugs shown, let alone having a second metal plug, a first barrier layer, and a second barrier layer all form a planar exterior surface of said integrated circuit structure. Rather, the structure in Kumar merely shows a single barrier layer and accompanying metal plug in a coplanar arrangement. Moreover, Zhao is similarly bereft of any description of multiple barrier layers or multiple metal plugs, let alone a planar structure. Thus, Kumar alone or in combination with Zhao simply fails to disclose the elements of the amended claimed invention.

Applicants reiterate their position in the previous Amendments, which provide that Zhao actually teaches away from, rather than toward, the claimed invention (wherein, as shown in Fig. 2, the solder ball 25 is disposed directly on the copper layer 24; the point of the copper layer immediately below the solder ball is to consume impurities, not to be protected from them 9c.f. page 10, lines 2-7 of the present specification).

BU999175

Similarly, as amended claims 9, 10, 13, and 22-28 are patentably distinct over Kumar in view of Zhao for the reasons provided above. Moreover, even if Kumar were combined with Zhao, Chang, and Havemann, it would still fail to disclose the unique elements provided by amended independent claims 13 and 23. Furthermore, the fact that four different references must be combined to try and teach, but failing nonetheless, the elements of the claimed invention is evidence that such a combination is not obvious. Simply stated, one of ordinary skill in the art at the time of the invention would NOT find it obvious to selectively combine elements from four different and wholly unique inventions to try and teach the claimed invention. To do so would require a stretched interpretation of obviousness.

Insofar as references may be combined to teach a particular invention, and the multiple proposed combinations of Kumar and Zhao; and Kumar, Zhao, Chang, and Havemann, case law establishes that before any prior art references may be validly combined for use in a prior art 35 U.S.C. § 103(a) rejection, the individual references themselves or corresponding prior art must suggest that they be combined.

For example, in In re Sernaker, 217 U.S.P.Q. 1, 6 (C.A.F.C. 1983), the court stated: "[P]rior art references in combination do not make an invention obvious unless something in the prior art references would suggest the advantage to be derived from combining their teachings." Furthermore, the court in Uniroyal, Inc. v. Rudkin-Wiley Corp., 5 U.S.P.Q.2d 1434 (C.A.F.C. 1988), stated, "[w]here prior-art references require selective combination by the court to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gleaned from the invention itself. . . . Something in the prior art must suggest the

BU999175

desirability and thus the obviousness of making the combination."

In the present application, the reason given to support the proposed combination is improper, and is not sufficient to selectively and gratuitously substitute parts of one reference for a part of another reference in order to try to meet, but failing nonetheless, the Applicants' novel claimed invention. Furthermore, the amended claimed invention meets the above-cited tests for obviousness by including embodiments such as "a second barrier layer above said first metal plug; a second metal plug above said second barrier layer, wherein said second metal plug, said first barrier layer, and said second barrier layer form a planar exterior surface of said integrated circuit structure, . . . wherein said second metal plug being in direct contact with said solder bump, wherein said first metal plug, said second metal plug, and said metal line comprise a same material, wherein said second metal plug forms sufficient intermetallics with elements diffusing from said solder bump so as to prevent said elements from penetrating through said first barrier layer and said second barrier layer into said metal line." As such, all of the claims of this application are therefore clearly in condition for allowance, and it is respectfully requested that the Examiner pass these claims to allowance and issue.

As declared by the Federal Circuit:

In proceedings before the U.S. Patent and Trademark Office, the Examiner bears the burden of establishing a prima facie case of obviousness based upon the prior art. The Examiner can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. In re Fritch, 23 U.S.P.Q.2d 1780, 1783 (Fed. Cir. 1992) citing In re Fine, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988).

BU999175

Here, the Examiner has not met the burden of establishing a prima facie case of obviousness. It is clear that, not only does Kumar fail to disclose all of the elements of the claims of the present invention, as admitted by the Office Action, and particularly the metal plug and the metal line comprising a same material, and the metal plug having a sufficient thickness and forming sufficient intermetallics with elements/species diffusing from the solder bump so as to prevent the elements from penetrating through the barrier layer into or adhering the metal line, as discussed above, but also, if combined with Zhao, Chang, and Havemann, fail to disclose these elements. The unique structure and method of the present invention is clearly an advance over the prior art.

The Federal Circuit also went on to state:

The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. . . Here the Examiner relied upon hindsight to arrive at the determination of obviousness. It is impermissible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that one cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. Fritch at 1784-85, citing In re Gordon, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984).

Here, there is no suggestion that either Kumar, alone or in combination with Zhao, Chang, and Havemann, teaches a structure containing all of the limitations of the amended claimed invention. Consequently, there is absent the "suggestion," or "objective teaching" that would have to be made before there could be established the legally requisite "prima facie case of

BU999175

obviousness."

In view of the foregoing, Applicants respectfully submit that Kumar, Zhao, Chang, and Havemann do not teach or suggest the features defined by amended independent claims 6, 13, and 23, and as such, claims 6, 13, and 23 are patentable over Kumar, Zhao, Chang, and Havemann. Further, dependent claims 2, 3, 9, 10, 22, and 24-31, are similarly patentable over Kumar, Zhao, Chang, and Havemann, not only by virtue of their dependency from a patentable independent claim, respectively, but also by virtue of the additional features of the invention they define. Thus, Applicants respectfully request that the prior art rejections be reconsidered and withdrawn.

II. Formal Matters and Conclusion

With respect to the rejections to claims 2-4, 6, 7, 9-11, 13, 14, and 22-28, claims 3, 6, 10, 13, 22, 23, 27, and 28 have been amended, above, to overcome these rejections. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections to the claims.

In view of the foregoing, Applicants submit that claims 2, 3, 6, 9, 10, 13, and 22-31, all the claims presently pending in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to

BU999175

discuss any other changes deemed necessary.

Please charge any deficiencies and credit any overpayments to Attorney's Deposit

Account Number 09-0456.

Respectfully submitted,

Dated: 4/23/2003



Mohammad S. Rahman
Reg. No. 43,029

McGinn & Gibb, P.L.L.C.
2568-A Riva Road
Suite 304
Annapolis, MD 21401
(301) 261-8625
Customer Number: 29154

FAX RECEIVED
APR 23 2003
TECHNOLOGY CENTER 2800